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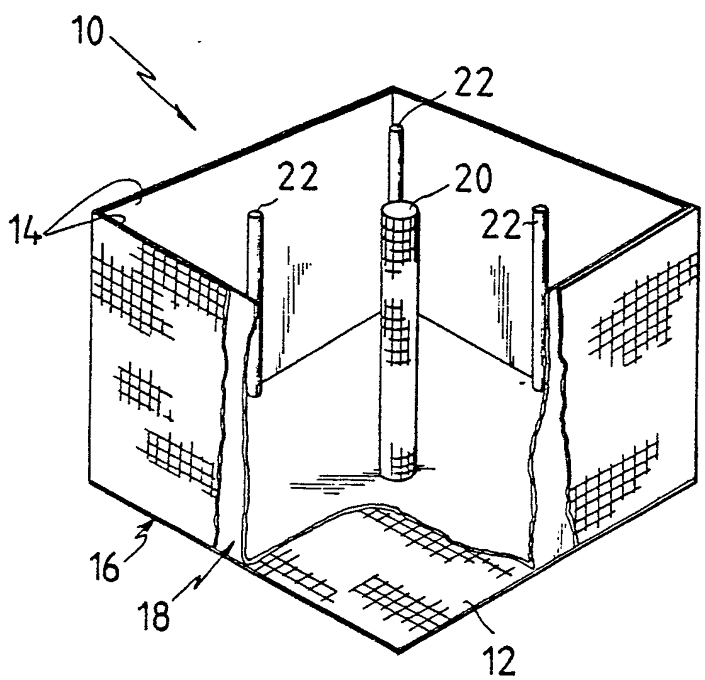

(57) Abstract

An electrode arrangement for use in dewatering and consolidating a fine suspension comprises an upwardly extending porous boundary wall (14) for a body of suspension to be dewatered and adjacent the boundary wall (14) at least one upwardly extending electrode (16) adapted to form part of an anode/cathode system. The electrode arrangement is used in a method of dewatering a body of suspension wherein it is provided at a boundary of the body of suspension and a dewatering electric power supply is applied across the at least one upwardly extending electrode (16) of the arrangement and at least one further electrode (22) provided within the body; said supply being applied for a time sufficient to achieve a desired degree of dewatering of the suspension.

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ELECTRODE-DRAIN STRUCTURES FOR DEWATERING OF SUSPENSIONS

This invention relates to a process and apparatus for consolidation of suspensions, such as those contained in ponds, dams, impoundments or tanks.

Suspensions of fine particles are very common, for example in mineral processing, coal preparation, metallurgical industries, textile, agricultural and food processing activities, in water purification, sewage treatment, and so on. Such fine suspensions are difficult to dewater and consolidate, and in the case of reject material or "tailings" this creates particular disposal difficulties. The problem is most conspicuous in the form of the ubiquitous tailings ponds, which are dams constructed from earth or coarse reject material to contain the fine slurry. Tailings are commonly left to settle for weeks, months, and even years in extreme cases. Even after such periods it is not unusual to find a surface crust of dried material some half a metre deep that blocks the drying of fluid material below. The impounded material therefore may not be permanently disposed of and the impoundment remains a long term environmental hazard that cannot be easily rehabilitated.

Electrical dewatering is a potential solution to this problem. Tests have been conducted by us for in-situ dewatering of impoundments have been carried out using electrodes emplaced before the impoundment if filled. In general, such tests have used horizontal electrodes and have given mixed results. Vertical electrodes have been tested on rare occasions, for dewatering existing impoundments already full of suspension, with success. The vertical electrodes comprised slotted or perforated metal pipes as cathodes inserted into a body of suspension to be dewatered. Such pipes also have been of limited success, as they provide a low ratio of cathode surface area to suspension volume. Also, fine filter medium or fabric has been used with the pipes to prevent their blockage by suspension solids. However the filter medium or fabric is prone to blockage and, in particular, is not well suited for use with fine particles frequently encountered with suspensions to be dewatered, and is found to fail in vertical arrangements. The present

invention is directed to providing an improved alternative process and apparatus, based on electrical dewatering, for the consolidation of suspensions.

The invention provides an improved electrode arrangement for use in dewatering and consolidating a fine suspension, the electrode arrangement comprising an upwardly extending porous boundary wall for a body of suspension to be dewatered and, adjacent the boundary wall, at least one upwardly extending electrode adapted to form part of an anode/cathode electrode system by which an electric potential can be applied to the body for dewatering the latter. Most conveniently, the electrode arrangement also enables consolidation of solids of the body of suspension by drainage, in addition to normal sedimentation.

The present invention enables a high ratio of electrode, in particular, cathode surface area to suspension volume. The porous boundary wall may comprise a peripheral enclosing wall for the body of suspension. Alternatively, it may comprise an internal wall, provided by a wall of at least one electrode vessel which itself has a high ratio of surface area to vessel volume and, thus, providing a high ratio of electrode surface area to suspension volume. In each case, the invention enables a significant improvement in the rate of dewatering, due to the relatively large surface area at which water can be removed from the body of suspension.

Also, at least in preferred forms fo the invention, the porous boundary wall includes or has associated therewith a layer of fabric which facilitates release or removal of water from the suspension. It is found that best results are achieved if the fabric has a relatively large pore size relative to at least the finer particles of the body of suspension to be dewatered, and if the fabric is hydrophilic. The fabric most preferably is a tough textile such as used as geotextiles. Thus, it is found that for satisfactory dewatering, the fabric is to provide a relatively coarse barrier for the cohesive suspension, and is chosen on the basis of criteria of pore size, hydrophilicity and capillarity of the fabric.

The electrode arrangement may provide at least part

of an external wall by which the body of suspension is contained. In a first embodiment of the invention where such external wall is provided, the electrode arrangement comprises a containment tank in which the body is formed by charging a quantity of a suspension into the tank. In a second embodiment in which such external wall is provided, the body of suspension is held in an impoundment having an upwardly extending porous said boundary wall defined by particulate material, with the at least one electrode of the arrangement being mounted adjacent the wall of that material.

Alternatively, the electrode arrangement may provide a hollow internal wall around which the body of suspension is contained. In a third embodiment of the invention, based on such internal wall form, the arrangement comprises a vessel structure positionable in the body.

The containment tank of the first embodiment has a base and, extending upwardly from the base, a peripheral wall which together with the base defines a holding volume for a body of suspension charged thereto for dewatering. The electrode of the tank is associated with the peripheral wall of the tank.

At least a portion of the peripheral wall, circumferentially of the tank and vertically, is porous to enable drainage of liquid from the suspension. The peripheral wall preferably is porous over substantially its full extent. Also, the base may be porous over part of its area, or over substantially its full area. To the extent that the peripheral wall and base of the tank is porous, it may be defined by a suitable porous fabric. Particularly where the peripheral wall is porous over substantially its full area, it most conveniently is defined by a strong porous fabric; while the same applies to the base. In each case, the fabric conveniently is a strong hydrophilic fabric. Geotextiles, such as traditionally used in road and embankment stabilization, are particularly suitable as the fabric; PROPEX 3220 being an example of such geotextile.

The fabric defining part or all of the peripheral wall and base of the tank may be supported. For this purpose, the tank may include a relatively rigid mesh material, this

most conveniently being provided over the external surface of the fabric. Such mesh material may extend over the full area of the peripheral wall and base of the tank, and this is preferred where such area is fully defined by fabric.

In one arrangement, the tank is of rectangular form in plan view and has its peripheral wall provided by four upstanding wall portions. In such arrangement, the base and each wall portion preferably is provided by a respective section of mesh material which has, over its inner surface, a section of fabric. In one form, successive wall portions may be inter-connected at their adjacent edges; with the lower edge of each inter-connected to an adjacent edge of the base. In another form, three of the wall portions may be so inter-connected to each other and to the base, with the fourth wall removably mounted so as to enable access to the interior of the tank from one side so that consolidated solids can be removed after dewatering is complete. In a variant of the latter form, the base rather than one wall portion is so removably mounted; the wall portions tapering outwardly towards the base to facilitate discharge of consolidate solids on removal of the base.

The mesh material of the tank may be metal mesh and, in such case, it provides the electrode. Most preferably it is welded metal mesh. However, if required, the mesh material can be formed of stiff plastics material.

Structural rigidity of the tank can be enhanced by a framework inside which the tank is positioned. The framework may comprise at least part of the electrode, but preferably is electrically non-conducting, and may be formed of a stiff plastics material. The framework may be of skeletal form; the form preferably being complementary to that of the tank. Also, the tank may simply sit in the framework so as to be able to be lifted therefrom, or it may be inter-connected with the framework by suitable clips, ties or the like.

In use of the tank, a suspension to be thickened is charged to the interior of the tank. Consolidation of the suspension then is able to proceed by draining of liquid from the suspension through the fabric and by sedimentation. However, these actions do not normally enable production of a

solid-like material from the solids of the suspension and electrical dewatering therefore most preferably is simultaneously employed. For such dewatering, direct current voltage is applied across two electrodes of an anode/cathode electrode system to establish in the suspension the mechanisms of electrophoresis and electrosmosis.

In one arrangement, the tank itself is adapted to provide one of the electrodes of the system, preferably as a cathode. Where the peripheral wall includes metal mesh, this may be made the cathode. In such case, further electrode means, the anode of the system, is provided by at least one electrode positioned in the interior of the tank. In an alternative arrangement, which is a preferred arrangement, the tank itself and a centrally located interior electrode each provide a respective cathode while the anode is provided by several electrodes preferably symmetrically disposed between the two cathodes. The or each electrode positioned in the interior of the tank may comprise a rod, sheet or mesh of conducting material.

The above-mentioned mechanisms, which also characterise the following embodiment, occur in conjunction with a structural release process in the suspension related to reorientation and translation of suspension particles into a more close-packed arrangement under the influence of the electric field of the applied voltage. Water thus collects both at the cathode and at the surface and, particularly where the container wall is made the cathode, water is able to be removed efficiently through the tank. Where at least one electrode positioned in the interior of the tank which is a cathode, enhanced water removal through the tank also occurs; although water removal in such case also is preferably further improved by such cathode defining a drain for the tank. Where the cathode provides such drain, it preferably is of upstanding, porous cylindrical form; the cathode, for example, being a cylinder of metal mesh which covered or filled with a filter material, such as a fabric as discussed above.

In the second embodiment of the invention, the at least one electrode (herein called a "wall electrode", which may be a wall cathode or a wall anode) of the electrode

arrangement is provided at or against at least one wall of the impoundment, with the or each wall electrode being adapted to be connected as part of an anode/cathode electrode system of an electrical dewatering system. The polarity of this or each wall electrode depends on the nature of the suspension, but is usually negative i.e. a cathode.

The impoundment, as normally is the case, may be constructed above ground or below ground level, with the impoundment walls being formed of sandstone, sand, coarse coal refuse, earth or overburden - usually a material that is conveniently available at the plant where the impoundments are located. These walls are naturally permeable to water, although not necessarily as permeable as, for example, carefully graded particulate media as is preferred in the invention and/or a fabric as detailed above. When an impoundment is filled with fine suspension, a deposit of fine particles can build up quickly on the walls. Although the walls themselves do not become completely "blinded" or "blocked", the low permeability of the deposited layer effectively controls the rate at which water from the suspension in the bulk of the impoundment can reach the walls, and this rate can become very slow. However, in the arrangement of the second embodiment, water is transported to the wall cathodes by the electric voltage applied between the wall cathodes and other electrode means (anodes) such electric transport being independent of the low hydraulic permeability of such deposit of fine particles. Once the water reaches the wall cathodes it is then in direct contact with the wall material itself and relatively free of solids, and is able to drain away to the exterior of the impoundment.

The wall electrodes can take the form of electrically conductive rods, pipes, or mesh and can cover any or all the parts of the boundary wall of the impoundment in part or in whole, and can also cover the base of the impoundment if this also is permeable. The wall electrodes may be simply placed against the boundary wall material. Alternatively they may be covered with porous fabric as discussed in relation to the first embodiment, such as Propex 3220, to further assist the soaking up and draining away of

water. Such fabric may be placed on the inside or the outside surface of the wall cathodes so that it is between the wall cathodes and the wall material, or between the wall cathodes and the suspension in the impoundment.

Other electrodes of an anode/cathode system of the electrical dewatering system, of which the wall electrodes form a part, preferably are suitably disposed in the interior of the impoundment, such as symmetrically along a central axis of the impoundment. The other electrodes of the system may comprise an array of anode rods, pipes or mesh and may be disposed horizontally, vertically or in both directions, such that the separations between the anodes and the wall cathodes on the walls and base are approximately the same at all locations, similar to the arrangement of the first embodiment of the invention except on a much larger scale. It is also possible to have multiple anodes interspersed with cathode-drain vessel structures as described herein in respect of the third embodiment. The optimum arrangement for any specified number of electrodes preferably is determined by mathematical modelling and computer simulation, although the invention permits use of any geometrical arrangement such as rectangular, square, circular (coaxial) and oblong.

Although the material of the impoundment walls may not be ideal with respect to hydraulic permeability, the surface area compensates for this. The large surface area available for wall cathodes also enables relatively large currents to be achieved for electrical dewatering; the rate at which water reaches the wall cathodes region being proportional to current.

This invention therefore enables the use of the walls of the impoundment as the drainage "sink" to be enhanced by wall cathodes laid on the walls. This arrangement utilises the natural permeability and water absorption ability of the material of the impoundment walls. The anodes may form a line or a rectangular box shape along a central axis of the impoundment such that the anode-cathode separation is approximately the same in all directions. As far as is known, neither wall electrodes nor wall electrode drains have been used or proposed prior to this invention. Also as far as is

known, mathematical modelling and computer simulation for optimising the disposition of electrodes is not used in the art.

In the second embodiment, the porous external wall provided by the impoundment may simply comprise particulate material. The wall electrodes may simply be placed against or adjacent that wall, or they may be at least partly imbedded in that wall. However, the external wall may be covered by a layer of porous fabric, such as the fabric described in relation to the first embodiment. Where such fabric is provided, the or each wall electrode may be located between the external wall and the fabric, or the fabric may be between the external wall and the electrodes. Forms for the electrodes have been discussed above, but one suitable form particularly where such fabric is provided comprises a metal mesh, such as weldmesh.

In an alternative arrangement of the second embodiment, the wall electrodes are anodes, rather than cathodes, with cathode drain structures being provided by an electrode system with which the second embodiment electrode arrangement is used. Such alternative enables dewatering to be conducted in an overall system in which water is repelled from the impoundment walls by the wall anodes, with water being drawn-off from cathode drain structures within the body of suspension. The water thus is able to be contained within the impoundment to an extent which substantially precludes its passage into and beyond the impoundment walls, a procedure which has significant benefits in dewatering a toxic waste impoundment. The cathode drain structures may, for example, be in accordance with the third embodiment of the invention, or of other forms which permit water to be drawn therefrom such as by siphoning or pumping.

The electrode structure of the third embodiment is in the form of a vessel; the structure having a self-supporting peripheral wall which extends between upper and lower ends of the electrode, and defines a cavity within the structure. The electrode structure is electrically conductive by provision of the at least one electrode of the arrangement so that it can be used as an electrode, while the wall also is

water-permeable over at least a major portion of its surface. In one form, the wall, or at least a major portion of its surface may be comprised of metal mesh material over which is provided a porous fabric; the mesh material providing the at least one electrode by which the structure is electrically conductive. Preferably, the entire wall is comprised of such mesh material and fabric, with the fabric most preferably provided over the outer surface of the mesh material.

In an alternative form, the structure has an electrically conductive element within the cavity and spaced from the wall. In that form, the wall may comprise such fabric and electrically conductive or non-conductive support means for the fabric. The conductive element may be of metal mesh material, a plurality of electrically inter-connected metal rods or a sheet metal member. The support means is adapted to hold the fabric in a substantially fixed, spaced relationship to the conductive element and may comprise a skeletal frame to which the fabric is secured. Over at least major surface areas of the wall, the support means may include mesh material of a suitable plastics material or a metal.

The porous fabric preferably is as discussed above in relation to the first embodiment. It is characterised by hydrophilic properties and most preferably provides capillary activity. The fabric also should have adequate strength and preferably also a large pore size relative to particles of a suspension with which it is to be used. Again, an example of a suitable fabric is PROPEX 3220 geotextile, which traditionally is used in road and embankment stabilization. Other fabrics can be used in this and the other embodiments, but other fabrics and media we have tested have been found to be less satisfactory than PROPEX 3220.

We have found that electrical treatment dewaters a suspension or sediment by two main mechanisms; the conventional electrokinetic transport which is generally towards the cathode, and a structural release process related to reorientation and translation of particles of the suspension into a more close-packed arrangement under the influence of the electric field. These mechanisms are manifested by collection of water at the cathode and at the

surface, respectively. A cathode used in such treatment must then be capable of collecting and removing most if not all of this water, and an electrode structure according to the third embodiment is particularly well suited to enabling these requirements to be met.

The electrode structure of the third embodiment most conveniently has a large surface area relative to the volume of its cavity, to enhance water collection. In one convenient arrangement, the structure has two major wall portions in relatively close, opposed relationship; with those wall portions being joined along adjacent side edges by two minor wall portions. Preferably the major wall portions are substantially rectangular, with the minor wall portions of elongate strip form.

In use, the electrode structure is emplaced after filling an impoundment, or in a pre-existing impoundment, with the peripheral wall extending upwardly and with the upper end of the structure uppermost. The lower end of the structure may be closed by an inperforate base or by a base of similar construction to the peripheral wall. Also, depending on the height of the structure relative to the depth of the impoundment, the upper end of the structure may be closed by a cover similar to the base.

The electrode structure most typically is used as a cathode in an anode/cathode electrode system including at least one, preferably several, anodes; with direct current voltage being applied across the cathode and anodes. In such use, with the electrode system positioned in a suspension, water of the suspension adjacent the electrode (cathode) structure wall is soaked up and percolates through the porous fabric into the cavity of the structure. The fabric acts substantially in the manner of a sponge, rather than as a filter, although the fabric can act as a mechanical barrier of coarse filter which substantially prevents solids of the suspension from passing into the cavity.

Most preferably the electrode structure has a height which provides a sufficient hydraulic head to ensure surface water, drainage water, electrokinetic transport water and also rain water enters the cavity. The water may be pumped or

siphoned intermittently to the outside from the cavity, via the upper end of the structure. Alternatively, the water may be drained automatically or pumped to the outside from the cavity, from a location at or adjacent to the lower end of the structure. The structure may have a water removal tube positioned for such pumping siphoning or drainage. Alternatively, where water removal is via the upper end, a water removal tube by which water is pumped or siphoned can be inserted intermittently into the cavity via that end to enable such water removal to be effected.

Reference now is directed to the accompanying drawings, in which :

Figure 1 shows, in perspective view, a containment tank according to the invention;

Figure 2 shows, in perspective view, an electrode vessel according to the invention;

Figure 3 shows a schematic representation of an impoundment according to the invention; and

Figures 4 and 5 show part sectional views of a corner of the impoundment of Figure 3, showing respective alternative forms of electrode arrangement according to the invention.

With reference to Figure 1, there is shown a tank 10 of overall rectangular or box-like form, having a base 12 and a peripheral wall defined by four side walls 14. The tank includes an outer shell 16 of welded steel mesh and an inner shell 18 of suitable filter fabric. Tank 10 may have side dimensions of about 3 metres by 2.4 metres; although it may be larger or smaller than this, as required. The mesh of shell 16 may, for example have openings of about 5cm, although this can vary widely. The fabric of shell 18 is suitable to enable water to drain from the solids of a suspension charged into tank 10; the fabric, for example, having openings of about 100 microns.

As shown, tank 10 is broken away at its front corner for ease of illustration of its form and the disposition of internal components. While one side wall 14 may be completely removable, or pivotally connected to an adjacent side wall or to base 12, the remaining walls 14 and base 12 preferably are

inter-connected at adjacent edges, such as by welding or suitable securement means. Shell 16 preferably also is a cathode.

Within tank 10, there is a centrally disposed electrode 20 which is made a cathode and, uniformly spaced around electrode 20, a number of electrodes 22 which are made anodes. Electrodes 20,22 with shell 16 as a cathode, provide an anode/cathode dewatering system. Thus direct current voltage is able to be applied across electrode 20 and each of electrodes 22, and/or across electrode 16 and each of electrodes 22, such as by means of a suitable rectifier (not shown).

Electrode 20 is of upright cylindrical form and has its lower end resting on or secured to base 12, such that water passing into electrode 20 is able to discharge through base 12. Electrode 20 is formed of metal mesh, but is covered by a layer of filter fabric (not shown) similar to that used for shell 18. Thus, water is able to pass into electrode 20, and thereby drain from tank 10, while solids from which the water is so drained are retained in the tank.

Each of electrodes 22 is a vertically disposed rod. Electrodes 22 are spaced upwardly from base 12 and inwardly from walls 14 by a suitable distance, such as about 800 mm. Electrodes 22 can be so positioned by suitable non-conducting means located in or above tank 10.

While not shown, tank 10 preferably is provided with structural rigidity by means of a suitable, electrically non-conducting framework inside which tank 10 is positioned.

In use of tank 10, a quantity of a suspension to be thickened is charged to the interior of the tank. Some consolidation, and resultant thickening, of the suspension proceeds by drainage of water through shell 18 and by sedimentation of solids of the suspension. However, these factors are insufficient to enable thickening to achieve a solid-like product from the suspension solids, and electrical dewatering is simultaneously employed to further enhance the rate and degree of consolidation. The electrical dewatering is obtained by applying a direct current voltage across electrodes 16 and/or 20 and electrodes 22, these electrodes

extending into the suspension. Resultant electrophoresis and electrosmosis occurs in conjunction with orientation and translation of particles of the suspension into a more close-packed arrangement under the influence of the electric field generated by the applied voltage. Water thus collects at electrodes 16 and/or 20, the cathodes, and passes through the fabric covering of those electrodes to drain from tank 10; while water also collects at the surface and also efficiently drains through shell 18 of tank 10.

The overall parameters, in suspension thickening according to the invention, depend on the nature of the suspension and the quality of water associated with it. However, the parameters are inherently flexible and can be adapted to suit the throughput of suspension and the dewatering time available. Example parameters for one suspension initially at 3 wt.%, and treated according to the invention using a tank as in Figure 1, after pre-thickening to about 15% solids in a conventional thickener, are:

Average anode-cathode separation - 0.5 m;

Average voltage - 100 V (at which level no special precautions are needed);

Current - 50A;

Dewatering time - 24 hours;

Electric energy consumption - 10 kilowatt hr/tonne (dry basis);

Final solids content - 70 wt.%.

Without drainage and electrical dewatering, only 33 wt.% solids is attained in 24 hours; while only about 44 wt.% solids can be obtained when, in the long term, equilibrium is reached.

Current and energy consumption can be more than an order of magnitude higher for other suspensions, representing the extremes likely to be encountered in, for example, coal preparation and sand washing. Current and energy consumption will vary with electrode separation and the time available to carry out the dewatering. The maximum energy consumption likely to be encountered is about 100 kilowatt hr/tonne, for some suspensions that are quite saline and are also impossible to dewater significantly by conventional mechanical means.

In Figure 2, there is shown an electrode structure 30, having a peripheral wall 32 which defines a cavity 34.

Wall 32 has front and rear major portions 36,38 which are held in a close, spaced relationship by narrow side portions 40. The lower ends of wall portions 40 are tapered and the lower edge margins of wall portions 36,38 merge to close the lower end 42 of the structure. Peripheral wall 32 comprises a metal mesh or weldmesh inner layer 44 and a porous fabric outer layer 46 secured to layer 44.

The structure of Figure 2 is of rectangular overall form but, due to the close spacing of wall portions 36,38, it has a large surface area relative to the volume of cavity 34. The structure most typically is used as a cathode in an electrode system. The structure can be positioned in a suspension with its upper open end 48 just above the surface of the suspension. In such case, the height of the structure may be slightly in excess of the depth of the impoundment. Alternatively, end 48 may be closed, and the structure initially floated in the suspension and allowed or caused to sink as the suspension is progressively dewatered and consolidated; this enabling the whole surface area of the structure to be utilized throughout the dewatering. In the latter case, in which the structure sinks, the electrode system of which the structure forms a part most preferably is initially floated and allowed or caused to sink.

The height of the structure 30 may be such that it approximately spans the final depth of the pond after dewatering, or it may be a lesser height since fringing of the electric field lines will ensure that the dewatering extends from the bottom of the structure to the actual bottom of the impoundment.

Structure 30 has a lug 52, integral with mesh layer 44, by which it is connectable to the other components of an anode/cathode electrode system. Most conveniently, lug 52 is connected to one of respective bus bars for anodes and cathodes which are adjacent the suspension impoundment and, via the bus bars, to a solid state rectifier. A similar arrangement can be used with tank 10 of Figure 1.

Removal of water from cavity 34 may be by one of a

variety of arrangements, such as described above. As shown, cavity 34 is divided by partitions 50 which extend between wall portions 36,38 and which strengthen the structure. Water may be removed separately from each of the compartments of cavity 34 resulting from partitions 50, via a respective outlet for each compartment at the upper or lower end of the structure. Alternatively, those compartments may be inter-connected through partitions 50 with water being able to be removed from all compartments through a single such outlet, such as outlet line 54 which is connectable, to a suction device.

Fabric layer 46 is hydrophilic, and further characterised by capillary action in use and a relatively large pore size relative to the particles of the suspension. Layer 46 may be of PROPEX 3220 or similar fabric, and acts as mechanical barrier or coarse filter. A fabric with a pore size of at least 100 microns is an example of one suitable for use of the structure in dewatering a suspension of particles of 95% below 20 microns and about 50% below 2 microns. Despite this disparity between the fabric pore size and the particle sizes, the particles form a cohesive structure, such as a house of cards arrangement, which prevents them from entering the pores of the fabric. However, the chemical nature and physical form of the fabric are such that water adjacent it is soaked up by the fabric and percolates into cavity 14 as previously described.

The electrode structure 30 can be of a form other than that described above and that shown in Figure 2. For example, the peripheral wall and, as a consequence, the cavity therein can be of cylindrical or conical form, or of a box-like form other than that shown in Figure 2. However, still further geometric forms can be used. Additionally, in all possible forms, the electrode structure can have at least one electrically conductive external panel 56, such as of metal mesh or weldmesh, projecting outwardly from the peripheral wall in a required direction. The or each such external panel may be electrically connected to the electrically conducting element of or within the peripheral wall, such as to mesh layer 44 in the arrangement of Figure

2. Where so electrically connected, the electrode structure may be adapted for connection to a bus bar via such external panel, rather than via a lug 52 as in Figure 2. Alternatively, the or each such external panel may be electrically isolated from the electrically conducting element of or within the peripheral wall, with that element and such panel being separately connectable to a bus bar. However, in each form, the or each external panel acts to channel water towards the peripheral wall, thereby enhancing the volume of the suspension from which the electrode structure strongly soaks up water for percolation into the cavity of the structure.

The shape and also the relative dimensions of the electrode structure of Figure 2 and, where provided, the external panels thereof can vary substantially. However, the degree of fluidity of the suspension at the time of emplacement of the structure is a factor to be taken into account in determining the parameters of shape and dimensions.

In-situ dewatering of a suspension may be carried out with a wide variety of electrode systems using an electrode structure as in Figure 2. For example, the electrode structure can be used as a cathode and one or more of these can be employed in an electrode system including an array of rod anodes such as anodes 22 of Figure 1, or panel-like anodes of metal mesh or sheet metal similar to panel 56. In a variant using such cathodes and anodes, a number of the cathodes can be positioned in a row or in circular array, with the anodes disposed around each cathode. In a further variant, using such cathodes, the anodes can be of a construction similar to the cathodes, with the electrodes disposed in at least one row or ring of alternating anodes and cathodes. In the latter alternative, the or each anode will receive only surface, rain water and also some initial drainage water into its cavity, although this will further enhance dewatering of the suspension.

In a further variant, the electrode structure of Figure 2 can be used as an anode, using plain cathodes in the form of rods or of panel-like form of metal mesh or sheet metal. Such variant would reduce the efficiency of dewatering

in most instances, although in rare cases it in fact is beneficial.

The operating parameters in dewatering are flexible and would be adapted to the size of the impoundment and the dewatering time available. The operating parameters also depend on the nature of the suspension being dewatered and on the quality of the water associated with it. Thus, while the electrode system for in-situ dewatering of different suspensions can be the same or similar, the procedures for using the electrode system generally differ and may be determined from laboratory tests.

As an example, we have successfully applied electrode systems using electrode structures as in Figure 2 to the in-situ dewatering of an impoundment some 60 m x 20 m in area and 4 m deep filled with tailings from sand washing. Using such structures as cathodes, of about 3 metres in height and width and 0.2 metres in thickness, anodes and cathodes were 4 m apart, and the applied voltage ranged from 100V to 135V and the current from 9A to 5A. Dewatering time was 2 months and electric energy consumption was approximately 0.5 kilowatt-hours per tonne of material on a dry basis. These figures were all in accord with extrapolations from laboratory tests. Considerable volumes of water arising from rainfall of 382 mm over the dewatering period were also removed. The consolidated tailings demonstrated extensive cracking extending to the bottom of the impoundment and had a "spadeable" consistency.

While a fabric pore size of 100 microns is detailed above in relation to a specific suspension particle size spectrum, the pore size can vary over a substantial range. In general, it is desirable to have a pore size of less than 250 microns in order to prevent the cohesive sediment itself from entering the cavity of the electrode structure. Most conveniently the pore size is in excess of 50 microns.

Figure 3 shows an impoundment 60, defined by a porous impoundment wall 62 and containing a body of suspension 64 to be dewatered. Wall 62 is formed from suitable available particulate material 65, such as sandstone, sand, coarse coal refuse, earth or overburden. Around the upstanding inner face

66 of wall 62, there is provided a wall electrode arrangement 68 according to the invention which, together with other electrodes, forms part of an electrode system according to the invention. In the arrangement of Figure 3, the wall electrode 68 is a cathode, with the other electrodes including a central cathode drain 70 and, around the later, a ring of anodes 72. A dewatering electric current is supplied to the electrode system by anode bus bar 74 connected to anodes 72 by leads 76 and a cathode bus bar 78 connected to wall electrode 68 and to cathode drain 70 by leads 80.

Figure 4 shows an alternative form of electrode arrangement on each wall portion 82,83 of wall 62. The arrangement on wall portion 82 corresponds to that of Figure 3 and, where used, most preferably would be provided around the full extent of wall 62. Similarly, the arrangement on wall portion 83, where used, most preferably would be provided around the full extent of wall 62. However, whether or not the alternative arrangements are provided around the full extent of wall 62, they in fact are alternatives and normally would not be used together.

In Figure 3, as illustrated by wall portion 82, wall electrode 68 comprises metal mesh 84 which defines an upstanding cathode placed against face 66 of wall 62. Water drawn from the body of suspension 64, during application of dewatering electric current via bus bars 74,78 to the anodes and cathodes, passes to mesh 84 and cathode drain 70. The water drawn to mesh 84 passes through the latter and drains into wall 62, and from wall 62 to the surrounding terrain.

Cathode drain 70 most preferably is an electrode vessel as shown in Figure 2. Water drawn to it passes through its peripheral wall, into the cavity thereof. From such cavity, the water can be drawn off from a suitable outlet line, such as line 54 of Figure 2, by siphoning action or a suction pump for discharge. Alternatively, if the base of impoundments is porous, one or more such line 54 can discharge the water into the base for dissipation therein.

As illustrated, anodes 72 comprise metal rods. However, they alternatively may comprise sheet metal anodes, such as shown at 86 in Figure 4, spaced from mesh 84 and

electrode drain 70; or it may comprise metal mesh.

Figure 5 shows a variant of Figure 3, as further illustrated by wall portion 82 of Figure 4. In Figure 5, mesh 84 is covered by a layer of fabric 88, similar to fabric 46 of electrode structure 30 of Figure 2. Mesh 84 alone is found to function well in conjunction with wall 62 in effecting dewatering of suspension 64, and dissipation of the water drawn to mesh 84. However, fabric 88 substantially prevents fines from the suspension from passing into, and blinding, the porous form of wall 62. In Figure 5, mesh 84 is shown as being between fabric 88 and wall 62, as is preferred; although fabric 88 can be provided between mesh 84 and wall 62, if required.

The electrode system of Figure 3, as further illustrated by wall portion 82 of Figure 4, is the preferred arrangement for dewatering and is suitable for use where suspension 64 does not contain toxic material in solution. However, where toxic material is present in solution in suspension 64, dissipation of water through wall 62 is not appropriate. In such case, mesh 84 is made an anode such that, under the action of a dewatering electric current via bus bars 74,78, water in suspension 64 is driven away from wall 62 to at least one electrode drain 70. In that event, there preferably will be a circular array of drains 70, with anodes 72 being in suspension 64 within that array.

Where dewatering is to be conducted by driving water away from wall 62, the anode constituted by mesh 84 can be of a form shown at wall portion 83. Wall portion 83 in fact illustates two forms of wall anodes, these comprising upright metal rods 90 and upright mesh tubes 92. A plurality of laterally spaced rods 90 or of tubes 92 can be disposed around face 66 of wall 62, or a combination of rods and tubes can be used, as shown.

Where suspension 64 contains toxic material in solution, water passes under the action of a dewatering current to the or each cathode drain 70 and is collected in the cavity of the or each cathode drain 70. Even where the base of impoundment 60 is porous, the collected water will not simply be drained into the base. Rather, the water will be

siphoned or pumped from the drains 70 for acceptable detoxifying treatment prior to discharge. Also, the base of impoundment 60 most preferably will be covered by a horizontal anode of suitable form by which water is driven away from the impoundment base.

The electrode arrangement of the invention enables significantly improved dewatering of suspensions, particularly in terms of overall time and the degree of dewatering in a given time. Enhanced results are achieved withn use of a hydrophilic fabric as part of the electrode arrangement, due to its hydrophilic nature and realtively large pore size, as well as its capillarity. The preferred fabrics also enable use of a high ratio of surface area at which dewatering is effected to suspension volume, and tolerate a high hydrodynamic head. A comparison of the fabric of the invention with some alternative fabric materials of similar pore size is set out in the following:

Material	Hydrophilicity	Capillarity	Performance
Propex 3220	High	High	Excellent
Nylon	Medium	Medium	Medium
Slotted plastic	Low	Low	Low

In each case, the surface area to volume ratio and hydraulic head provided with the drain, of which the respective fabrics were part, were high. If either or both of these parameters were reduced for any of the fabrics, the performance was also reduced.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention.

CLAIMS:

1. An electrode arrangement for use in dewatering and consolidating a fine suspension, the electrode arrangement comprising an upwardly extending porous boundary wall for a body of suspension to be dewatered and, adjacent the boundary wall, at least one upwardly extending electrode adapted to form part of an anode/cathode electrode system by which an electric potential can be applied to the body for dewatering the latter.

2. An electrode arrangement according to claim 1, wherein said boundary wall provides at least part of an external wall by which the body of suspension is contained.

3. An electrode arrangement according to claim 2, wherein said external wall is defined by the peripheral wall of a containment tank in which said body is formable by charging a quantity of suspension into the tank, the upwardly extending electrode forming part of said peripheral wall.

4. An electrode arrangement according to claim 2, wherein said external wall is defined by an upwardly extending said boundary wall of particulate material against which said upwardly extending electrode is provided.

5. An electrode arrangement according to claim 4, wherein said wall of particular material is defined by an impoundment wall of particulate material.

6. An electrode arrangement according to claim 1, wherein said boundary wall provides a hollow internal wall around which the body of suspension is contained.

7. An electrode arrangement according to claim 1, wherein said internal wall comprises a vessel structure positionable within said body of suspension and defining an internal water receiving cavity.

8. An electrode arrangement according to any one of claims 1 to 7, in which said boundary wall is defined at least in part by a layer of porous fabric.

9. An electrode arrangement according to claim 8, wherein said fabric is a hydrophilic geotextile.

10. An electrode arrangement according to claim 8 or claim 9, wherein said fabric has a pore size of less than 250 microns.

11. An electrode arrangement according to claim 10, wherein said fabric has a pore size in excess of 50 microns, such as from 100 to 250 microns.

12. An electrode arrangement according to any one of claims 1 to 11, wherein said boundary wall includes a layer of mesh of a rigid material.

13. An electrode arrangement according to claim 12, wherein said mesh is a metal mesh and comprises the at least one electrode.

14. An electrode arrangement according to claim 12, wherein said mesh is a plastics mesh, the at least one electrode comprising a metal member associated with said boundary wall.

15. An electrode according to claim 14, wherein said electrode is of a form selected from sheet, tubular and rod form.

16. An electrode arrangement according to any one of claims 1 to 15, including at least one further electrode, with the at least one upwardly extending electrode and said at least one further electrode disposed in a suitable array and electrically inter-connected for applying a dewatering electric power supply to the body of suspension.

17. A method of dewatering body of a suspension, wherein an electrode arrangement according to claim 1 is provided at a boundry of the body, and a dewatering electric power supply is applied across the at least one upwardly extending electrode of the arrangement and at least one further electrode provided within the body, said supply being applied for a time sufficient to achieve a desired degree of dewatering of the suspension.

18. A method according to claim 17, wherein said at least one upwardly extending electrode is defined by the peripheral wall of a containment tank into which the body of suspension is charged, the upwardly extending electrode forming part of said peripheral wall being made a cathode with at least one said further electrode being an anode.

19. A method according to claim 17, wherein said boundary wall is defined by a porous impoundment wall of particulate material with said at least one upstanding

electrode being disposed over an inner surface thereof, said at least one upwardly extending electrode being a cathode and at least one said further electrode being an anode, and wherein said cathode is positioned over an internal surface of said impoundment wall, the or each said anode is positioned within said body of suspension, and dewatering is conducted so that at least a portion of water drawn from the suspension by dewatering and allowed to pass into said impoundment wall.

20. A method according to claim 17, wherein said boundary wall is defined by a porous impoundment wall of particulate material with said at least one upstanding electrode being disposed over an inner surface thereof, said at least one upwardly extending electrode being an anode and at least one said further electrode being a cathode defining a water receiving cavity, and wherein said anode is positioned over an internal surface of said impoundment wall, the ore each said cathode is positioned within said body of suspension, and dewatering is conducted so that water in said suspension is driven away from said impoundment wall by dewatering and allowed to pass into the cavity of the or each cathode.

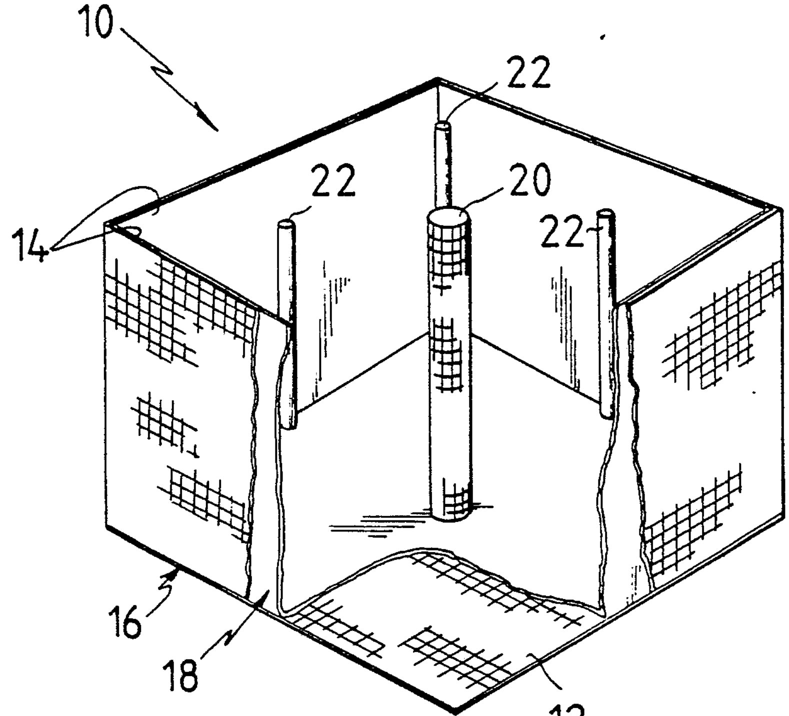
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FIG 1

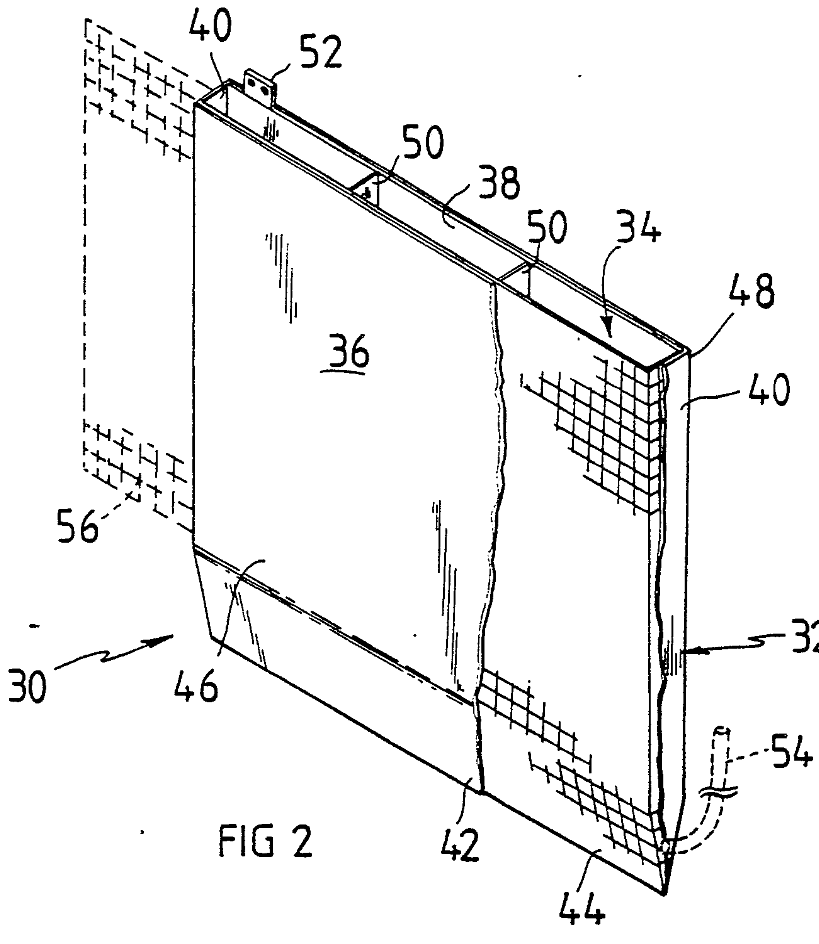
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FIG 2

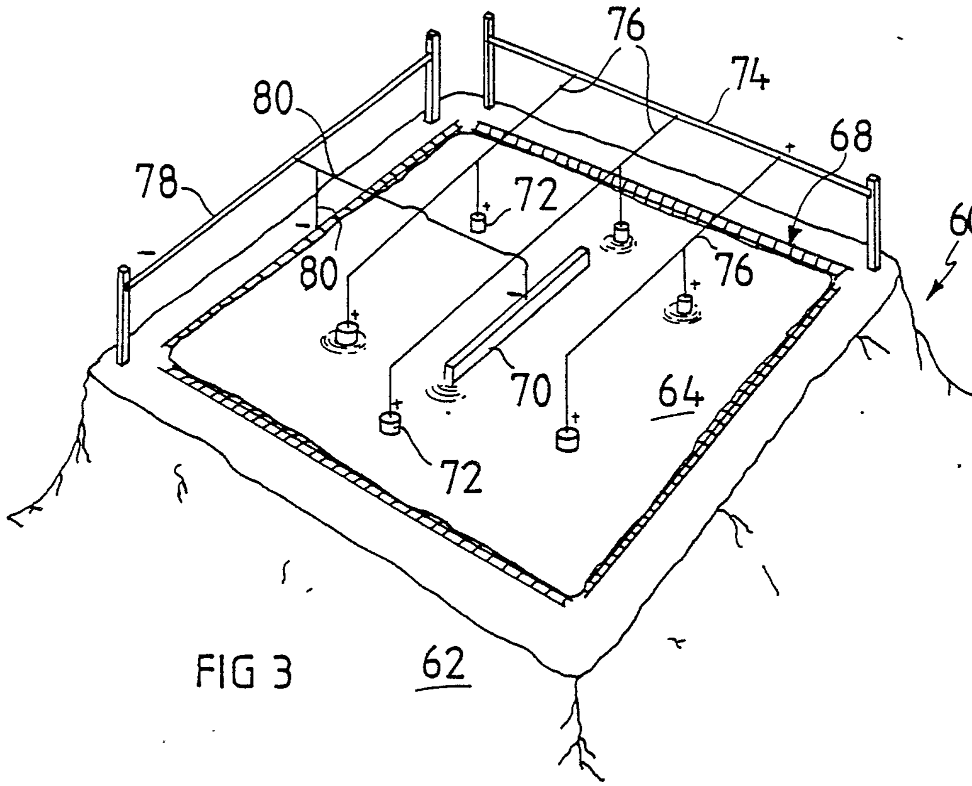
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FIG 3

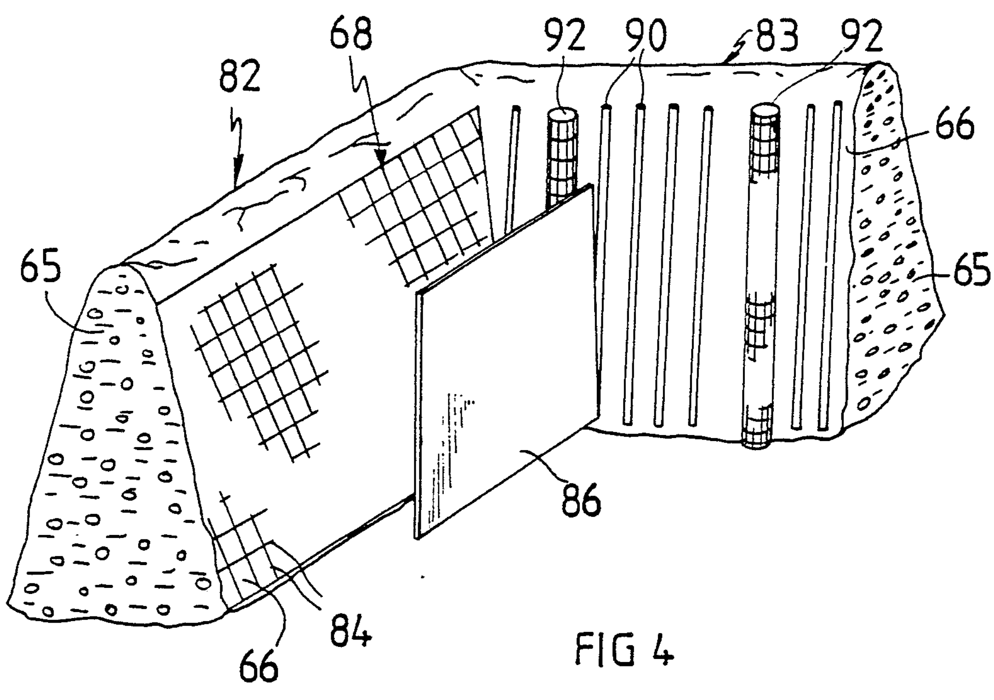
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FIG 4

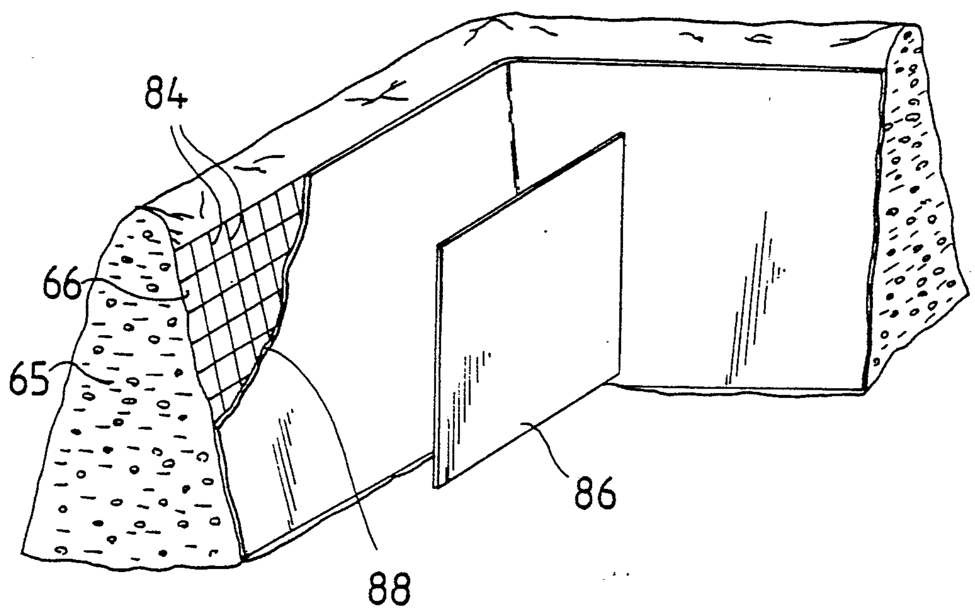

FIG 5

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 86/00234

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{4} B03C 5/00, 5/02, B01D 35/06, 43/00

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	B03C 5/00, 5/02, B01D 35/06, 43/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y,P	US,A, 4569739 (KLINKOWSKI) 11 February 1986 (11.02.86)	(1)
Y	US,A, 4207158 (FREEMAN) 10 June 1980 (10.06.80)	(1-20)
Y	GB,A, 2123438 (DORR-OLIVER INC.) 1 February 1984 (01.02.84)	(1-20)
Y	GB,A, 2143850 (LLEWELLYN) 20 February 1985 (20.02.85)	(1-20)
A	US,A, 4111768 (SCHMIDT) 5 September 1978 (05.09.78)	(1)
A	AU,A, 57258/80 (SREDNEAZIATSKY NAUCHNO-ISSLEDOVATELSKY INSTITUT PRIRODNOGO GAZA) 2 October 1980 (02.10.80)	(1)
Y	FR,A, 2001002 (BRUNSWICK CORPORATION) 19 September 1969 (19.09.69)	(1)
Y	DE,B, 1197437 (N.V. PHILLIPS GLOEILAMPENFABRIEKEN EINDHOVEN (NIEDERLANDE)) 29 July 1965 (29.07.65)	(1)

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
(25-11-86)	25 NOVEMBER 1986
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	A.W. WINCH

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL APPLICATION NO. PCT/AU 86/00234

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
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US 4569739	ZA 8509325		
US 4207158	BE 855796 DE 2726604 IN 155949 US 4107026 ZA 7703147	BR 7703895 FR 2354802 JP 52154183 US 4168222	CA 1084873 GB 1568286 NL 7706125 US 4170529
GB 2123438			
GB 2143850			
US 4111768	US 4053386		
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FR 2001002	BE 727670 DE 1903818 NL 6901351	CH 500014 DE 1921990	DE 1921989 DE 1921991

END OF ANNEX

DERWENT-ACC-NO: 1987-064792

DERWENT-WEEK: 198834

TITLE: Electrode system for dewatering fine suspension has porous boundary wall with adjacent electrode

INVENTOR: LOCKHART N C; STICKLAND R E

PATENT-ASSIGNEE: COMMONWEALTH SCI & IND RES ORG [CSIR] , LOCKHART N C[LOCKI]

PRIORITY-DATA: 1986AU-005962 (May 19, 1986) , 1985AU-001958 (August 15, 1985) , 1986AU-062271 (August 16, 1985) , 1986AU-000047 (February 25, 1986) , 1986AU-004786 (February 25, 1986)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
WO 8701057 A	February 26, 1987	EN
AU 8662271 A	March 10, 1987	EN
EP 269628 A	June 8, 1988	EN
JP 63501694 W	July 14, 1988	JA

DESIGNATED-STATES: AU JP US AT BE CH DE FR GB IT LU NL SE AT BE CH DE FR GB IT LI LU NL SE

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
WO1987001057A	N/A	1986WO-AU01057	August 15, 1986
EP 269628A	N/A	1986EP-905146	August 15, 1986
JP 63501694W	N/A	1986JP-504515	August 15, 1986

INT-CL-CURRENT:

TYPE	IPC DATE
CIPS	B01D24/00 20060101
CIPS	B01D29/01 20060101
CIPS	B01D35/06 20060101
CIPS	B01D43/00 20060101
CIPS	B03C5/00 20060101
CIPS	B03C5/02 20060101

ABSTRACTED-PUB-NO: WO 8701057 A

BASIC-ABSTRACT:

Fine suspension to be dewatered and consolidated is confined by an upwardly extending porous boundary wall . At least one upwardly extending electrode is provided adjacent the boundary wall arranged to form part of an anode/cathode electrode system by which an electric potential can be applied to the

suspension.

Boundary wall may be part of an external wall of the pond contg. the suspension or a hollow internal wall formed by a vessel structure positioned in the suspension. The boundary wall may be formed at least in part by a porous hydrophilic geotextile, and the electrode may be a metal mesh. The other electrode can be a vertical electrode positioned within the body of suspension.

USE/ADVANTAGE - Dewatering and consolidating a suspension of fine particles, e.g. in mineral processing, coal prepn., metallurgical, textile, agricultural and food processing industries, in water purificn. or sewage treatment. Provides a high ratio of electrode area to suspension vol. enabling an improvement in the rate of dewatering.

TITLE-TERMS: ELECTRODE SYSTEM DEWATER FINE SUSPENSION POROUS BOUNDARY WALL ADJACENT

DERWENT-CLASS: D15 J01 P41

CPI-CODES: D03-K09; D04-A01B; D04-A01M; D04-B10A; J01-F;

SECONDARY-ACC-NO:

CPI Secondary Accession Numbers: 1987-027042

Non-CPI Secondary Accession Numbers: 1987-049031